

BEFORE THE  
**FEDERAL COMMUNICATIONS COMMISSION**  
WASHINGTON, D.C.

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**FEB 25 1994**

**FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF SECRETARY**

In re Petition for Rulemaking by )  
General Motors Research Corporation )  
for Spectrum Allocation for Use by )  
Vehicle Radar Safety Systems )

RM No. 8308

To: Office of Engineering and Technology

**SUPPLEMENTAL COMMENTS OF VORAD SAFETY SYSTEMS, INC.**

VORAD Safety Systems, Inc. ("VORAD"), a subsidiary of IVHS Technologies, Inc., by its attorneys, hereby submits the following supplemental comments in the captioned proceeding in response to Comments filed by the American Automobile Manufacturers Association ("AAMA"). In addition to consideration of the frequencies requested by AAMA, VORAD requests that the Commission undertake expedited allocation of a 200 MHz band in the 46 GHz to 50 GHz region of the spectrum for use under Part 15 of FCC Rules by vehicular on-board radar systems, so that the proven and dramatic safety enhancement experienced by VORAD-equipped trucks and busses can quickly be made available to passenger vehicle occupants.

**I. Introduction**

VORAD, a small business enterprise located in San Diego, California, is the first company in the United States to develop and market a radar-based driver alert safety system. VORAD (including its corporate predecessors) has more than 20 years of experience in researching and developing such systems, and has installed them in approximately 1800 commercial vehicles, including the nation's largest commercial bus fleet, owned by Greyhound Lines, Inc. Adapted from the

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defense aerospace industry and using an antenna developed with M/A-COM, 1/ VORAD's system is at the frontier in applying U.S.-developed aerospace technology to civilian commercial uses. 2/

VORAD's driver alert safety system functions as an "electronic eye," watching the road to determine the speed and position of objects ahead, and warning drivers with visual and audible signals when another vehicle or stationary object is too close. Using standard Doppler radar techniques and a transmission/reception system presently authorized to operate at 24.725 GHz, 3/ VORAD's warning system gives drivers a significant margin of additional reaction time to apply the brakes or take other evasive action when necessary.

This additional time can prevent accidents and save lives. Greyhound Lines has recently completed its first full year of service with VORAD's on-board radar safety system in place. With almost 100 million miles logged in that time, Greyhound's 1993 year-end safety data show that the company's total accidents were significantly reduced last year by more than 20 percent over 1992 levels. 4/

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1/ M/A-COM is a major U.S. micro- and millimeter-wave component manufacturer and defense industry contractor, now converting to commercial system production.

2/ VORAD employs 55 persons, including engineers and technicians in the southern California region that for years has been economically dependent on the defense industry.

3/ VORAD's equipment was authorized to operate at 24.125 GHz, but, pursuant to a waiver of the fundamental frequency of operation in Section 15.245 granted by the FCC in September 1993, is currently authorized at 24.725 GHz,  $\pm 50$  MHz. See September 20, 1993 letter from Thomas P. Stanley to Susan Wing, counsel for VORAD.

4/ See February 18, 1994, letter from James D. Renforth, Director of Safety and Security, Greyhound Lines, Inc. to Paul J. Bouchard, President of VORAD, Attachment 1.

The company attributes this -- its "lowest level in 25 years" -- largely to the effectiveness of VORAD's safety system. *Id.* Since it first installed VORAD's equipment, Greyhound has continuously monitored its drivers' reactions to VORAD's warning system and has found that the system "significantly contributes to driver alertness and safety." A key feature for Greyhound's drivers is VORAD's successful operation in darkness, dense fog and other adverse weather conditions. *Id.*

The safety benefits and technologically advanced nature of VORAD's equipment have also been recognized by the financial and insurance industries and by a major supplier to vehicle manufacturers. VORAD recently entered into a global joint venture with Eaton Corporation and a consortium including M/A-COM, Allstate Insurance Co., and AIL Systems. The financial support of its joint venturers allows VORAD to focus on further technological advancements in its equipment. <sup>5/</sup> With its proven, field-tested technology, and with the allocation requested herein, VORAD intends now to move forward to produce and market vehicle safety systems suitable for passenger and light utility vehicles. The company expects that within 6 to 12 months of favorable FCC action on its request, it can begin distribution of its safety system to the consumer vehicle market.

VORAD's strategic plan to bring its truck- and bus-tested safety system to the significantly greater consumer automobile market depends largely on the effectiveness, practicality and general appeal of its system in that market. To achieve this market appeal, VORAD must both reduce its antenna size to

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<sup>5/</sup> VORAD's technology has also been developed and applied through cooperative undertakings with research universities and government agencies, including the University of California at Berkeley, the University of Southern California, the California Department of Transportation, the National Highway Traffic Safety Administration, and the Federal Highway Administration.

dimensions aesthetically and aerodynamically suited to passenger vehicles, and do so in a cost-effective way that will not price the equipment out of the range of many consumers.

These two interrelated factors -- antenna size and equipment cost -- have governed VORAD's focus on the 46 GHz to 50 GHz region of the spectrum for its next generation of consumer automobile equipment. Antenna size is, in general, inversely proportional to frequency: as the antenna aperture decreases, the operating frequency must increase. However, at higher and higher frequencies, equipment component costs can today be prohibitive, and for many spectral regions components are not available at all. To address these concerns, VORAD's engineers have developed a prototype antenna at 46.5 GHz by essentially doubling certain key components in its current 24 GHz equipment, thereby achieving significant antenna aperture reductions in a cost-effective manner.

As discussed below, frequencies in the 46 GHz to 50 GHz range are available and can be expeditiously allocated for use under Part 15 so that radar-based driver alert safety systems can quickly be made available to the large U.S. passenger vehicle market. Especially in light of the dramatic accident rate reductions already experienced by commercial busses and trucks now using VORAD safety systems, such expedited action by the Commission will serve the public's interest in safer, more economic highway transportation.

## **II. The Allocation Requested**

The AAMA has requested that the FCC consider six different wide-band frequency allocations in the millimeter wave spectrum to accommodate future

generations of radar-based driver alert systems. 6/ Although VORAD believes that the Commission should study the feasibility of the allocations requested by the AAMA, it believes for several reasons that its complimentary proposal for an immediate allocation under Part 15 of the Commission's Rules in the 46 GHz to 50 GHz range is the surest way for the Commission to promote near-term availability of such equipment for passenger cars and other light duty vehicles.

AAMA's three members -- General Motors, Ford and Chrysler -- have recognized that the vehicular on-board radar systems they have on the drawing board for use in their requested bands are years away from development and commercial availability. 7/ The VORAD system, on the other hand, operating in the 24 GHz region, is already in commercial use. Because of the harmonic relationship between 24 GHz and the 46 GHz to 50 GHz band, VORAD requests an allocation in the 46 GHz to 50 GHz range that will allow immediate employment of presently available 24 GHz frequency components (together with frequency doublers) in a downsized unit acceptable for use on passenger vehicles. With such an allocation, systems in the 46 GHz to 50 GHz spectral region can be brought to market years

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6/ One of the bands AAMA has requested for permanent allocation is "24.75 to 25.25 GHz," also referred to as "27.725 GHz  $\pm$  25 MHz. AAMA Comments at Table 2.1. Although the AAMA states that this band is currently used by VORAD pursuant to its waiver, VORAD's authorization is for 24.725 GHz,  $\pm$ 50 GHz. The AAMA has informally indicated to VORAD that this requested frequency was identified to accommodate VORAD's permanent use of it; however, as stated below, with an allocation in the 46 GHz to 50 GHz range, VORAD intends to shift its manufacturing out of the 24 GHz region altogether.

7/ For example, Ford has characterized collision avoidance radar as a "potential" vehicle system, which is "perhaps several years away." See Comments of Ford Motor Company filed in the captioned docket on September 1, 1993; see also Petition of General Motors Research Corporation in the captioned docket, filed July 13, 1993, recognizing that GM is two to three years away from marketing its own "initial application" of a driver alert safety system.

earlier, and much more cost effectively, than those that would employ other proposed frequency bands.

Moreover, because VORAD proposes a non-exclusive allocation to be used under Part 15 of the Commission's Rules, whereas the AAMA suggests dedicated frequencies and establishment of a special "vehicle radar service," VORAD believes that its complementary proposal can be implemented more expeditiously as an administrative matter. An additional benefit is the spectral efficiency of VORAD's 46 GHz to 50 GHz proposal. Whereas the AAMA has suggested that the Commission study allocation of multiple one- and two-GHz bands, for use with vehicle radar safety equipment that would operate with between 10 and 100 mW transmitter power, deployment of VORAD's system in the 46 GHz to 50 GHz region would require only 200 MHz of spectrum and approximately one milliwatt transmitter power.

For all these reasons, as discussed below, VORAD requests that the Commission expeditiously implement its immediately deployable, spectrally efficient 46 GHz to 50 GHz proposal, while initiating study of the several frequencies the AAMA proposes for exclusive allocation to a new vehicle radar service.

#### **A. The 46 GHz to 50 GHz Region**

As stated above, VORAD requests allocation of a 200 MHz band in the 46 GHz to 50 GHz area. The preferred allocation is one centered on 46.5 GHz, where VORAD has already developed an experimental system. See, Engineering Statement, Attachment 2. With an allocation at 46.5 GHz, VORAD could bring to market within six months a cost-effective commercial product based on its prototype equipment. As explained in the Engineering Statement, however, a 200 MHz wide allocation anywhere within the 46 GHz to 50 GHz range would also permit equipment development based on these frequencies' harmonic relationship with

24 GHz. With an allocation in this 46 GHz to 50 GHz region, but not centered on 46.5 GHz, commercial product development would be somewhat delayed, but could be brought to market within approximately one year of the allocation. 8/

The domestic allocation tables for the 46 GHz to 50 GHz range allow both government and non-government frequency use; specific allocations however (with the exception of a 200 MHz Amateur and Amateur Satellite allocation) currently provide only for government use. As set out in the Engineering Statement, VORAD understands that discussions are currently underway between the National Telecommunication and Information Agency ("NTIA") and the FCC, whereby NTIA would release to the FCC some portion of this spectrum for non-government use. We further understand that one of the frequency bands under consideration for release by NTIA lies between 47.2 GHz and 50.2 GHz. Because this spectrum band is within the 46 GHz to 50 GHz range with a harmonic relationship to 24 GHz, a 200 MHz band within it would be suitable for VORAD's proposed allocation.

As discussed in the attached Engineering Statement, the spectrum between 46 GHz and 50 GHz is currently allotted primarily to Fixed, Fixed Satellite

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8/ A greater than *de minimus* change in the center frequency of operation requires costly and time-consuming retooling of the antenna. The narrowband antenna employed by the VORAD system cannot easily be tuned from one frequency to another, but must undergo another design and development iteration if the frequency assignment changes by 200 MHz or more. For example, when it changed from 24.125 GHz to 24.725 GHz pursuant to the Commission's September 1993 waiver, VORAD incurred hundreds of thousands of dollars of expense and spent five months to re-engineer and produce the same product at the new frequency. A similar expenditure of time and money would be necessary if the frequency assigned in the 46 GHz to 50 GHz range varies more than 200 MHz from 46.5 GHz.

(earth to space) and Mobile use. <sup>9/</sup> Because the band is restricted to government use, it has not been possible to determine all specific usage; the Engineering Statement establishes, nonetheless, that predicted interference between existing and likely users and VORAD's proposed use is highly improbable.

#### **B. Traditional Part 15 Regulation**

VORAD currently holds an equipment authorization certification for its driver alert safety system as a field disturbance sensor pursuant to Section 15.245(b)(1)(iii). With the requested allocation for operation in the 46 GHz to 50 GHz region, VORAD proposes that its system would continue to comply with all conditions of operation of Part 15 including spurious emissions, harmonic levels and overall frequency stability. Additionally, VORAD proposes that the bandwidth and power limitations within which its 46.5 GHz prototype equipment currently operates be adopted for permanent operation under Part 15: that is, as discussed more fully in the Engineering Statement, VORAD's prototype equipment employs approximately one milliwatt of transmitter power, and produces a field strength of less than 5000 mV/m measured at 3 meters; the nominal bandwidth of the modulated signal (continuous wave, frequency modulation) is 2 MHz, which with typical oscillator frequency drift results in a possible frequency variation of  $\pm 100$  MHz, requiring an operating bandwidth of only 200 MHz.

A fundamental condition of operation under Part 15 is that a user not cause harmful interference to other authorized users and must accept any interference received. As discussed above and more fully in the Engineering Statement, VORAD has extensive operating experience under Part 15 criteria, with no interference caused to or received from other authorized users. It expects to be

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<sup>9/</sup> A small portion of this spectrum, at 48.94 GHz to 49.04 GHz, is allocated to radio astronomy.



similarly compatible with the same general types of Part 15 users in the band requested for allocation here. If new categories of users are proposed in the future, the question of compatibility with the VORAD system would have to be addressed at that time.

The only question of a potentially inconsistent use with that proposed by VORAD was addressed by the Commission's Office of Engineering and Technology ("OET") in granting VORAD's September 1993 waiver. 10/ There, OET recognized that certain unlicensed wideband radar *detectors* -- whether operating legally or illegally under state laws -- sometimes emit "false" alarms when they encounter VORAD's signal. Because some operators of these radar detectors have subjected drivers of VORAD-equipped vehicles to harassment and embarrassment, OET allowed VORAD to shift the frequency of operation of its system outside the frequency range in which police radar operates. Lest this same scenario be encountered in the 46 GHz to 50 GHz region, VORAD requests that no police radar be permitted to operate within one GHz of the center frequency of the allocation requested herein.

### **C. Expedited Allocation is Requested**

The accident reduction and improved safety record compiled by Greyhound is dramatic evidence of the highway driving benefits already achieved by trucks and busses using VORAD's driver alert safety system. VORAD now requests that the Commission take action that will expeditiously make available the same safety equipment priced and sized for the passenger vehicle market.

VORAD believes that the AAMA and several other parties filing comments in this proceeding share the goal of widespread availability of this safety

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10/ See September 20, 1993 letter from Thomas P. Stanley to Susan Wing, counsel for VORAD.

equipment for passenger vehicles, and it therefore supports proposals that the Commission study whether a new vehicle radar service should be implemented, whether exclusive or protected allocations are required for the new service, and what frequency bands and operating parameters are appropriate for allocation to the new service. However, VORAD is concerned that the extensive nature of the proposals contained in the AAMA's comments may have the unintended effect of slowing down immediate availability of radar safety systems to passenger car drivers, or of making them so expensive in the near term that they are beyond the price range of most of these drivers. For example, by requesting exclusive or protected allocations in the context of an entirely new radio service, the AAMA is asking the Commission to initiate an extensive and potentially protracted proceeding that, as an administrative matter, realistically cannot be completed for a year or perhaps longer. Similarly, the AAMA's request for allocation of frequencies for which components are presently expensive or unavailable will mean either that the price of passenger vehicle safety equipment will be beyond the means of many consumers, or that development will be delayed until cost-effective components are developed and mass produced.

VORAD's proposal, on the other hand, is straightforward: it seeks allocation of a 200 MHz wide band in the 46 GHz to 50 GHz region for use at low power under Part 15 of the Commission's Rules by VORAD and other authorized users. With this allocation, VORAD will be able to take "off the shelf" components and design, manufacture and immediately market vehicular on-board radar systems sized and priced right for the consumer vehicle market. The public interest of the driving public in sharing the safety and cost benefits already experienced by

Greyhound Lines 11/ supports VORAD's request that the Commission act expeditiously to make the proposed 200 MHz allocation.

Expeditious action on VORAD's proposal would serve other national interests as well. Thus, VORAD -- a small business enterprise with headquarters in San Diego, an area of southern California that has been hit particularly hard by defense industry layoffs -- would be able to continue expanding its employment of former defense industry engineers and technicians in applying U.S.-developed aerospace technology to civilian commercial uses. 12/

**D. VORAD's Proposal Compliments the AAMA Request**

The AAMA's comments are presented as the "broad based agreement . . . of the American automotive industry" regarding the need for and best way to implement spectrum allocation for use by radar-based collision avoidance systems. To this end, the AAMA requests the Commission to allocate numerous frequencies with corresponding operating limits to satisfy the varying needs of its members, Chrysler Corporation, Ford Motor Company and General Motors. The AAMA notes that the requested frequency bands, ranging from 24.75 GHz to 154 GHz, 13/ would accommodate "the unique requirements of all separate types of vehicle radar" to be manufactured by its members. AAMA Comments at 3. Importantly, the AAMA

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11/ Greyhound has "realize[d] a reduction in insurance, claims, injuries and other costs associated with vehicular accidents." See February 18, 1994, letter from James D. Renforth, Director of Safety and Security, Greyhound Lines, Inc. to Paul J. Bouchard, President of VORAD, Attachment 1.

12/ An additional benefit of expedited action is that, with a near-term allocation in the upper 40 GHz region, VORAD will be able to shift its entire production into that band, eventually eliminating the need for the Commission to consider extending VORAD's 24.725 GHz waiver, which will expire in September 1995.

13/ As noted above, the AAMA has incorrectly identified VORAD's current operating frequency as 24.75 GHz instead of 24.725 GHz. See footnote 5 above.

asks that the Commission consider exclusive allocations for use within the proposed new "vehicle radar service," *id.* at 4, and discusses the respects in which future generations of vehicular radar will incorporate vehicle braking and other vehicle control functions. <sup>14/</sup> *Id.* at 2.

VORAD supports the AAMA's request that the Commission begin now to consider spectrum allocations and interference protection to accommodate future generations of collision avoidance systems that will incorporate vehicle control functions. Such considerations, however, should not preclude simultaneous FCC action on VORAD's own request. That is, because VORAD proposes a course of action for the Commission that will allow immediate deployment of today's driver alert safety systems packaged and priced for consumer vehicles, the allocation requested herein is complimentary to the AAMA's proposed allocation for next-generation equipment, not inconsistent with it. Especially because, as discussed above, AAMA members have stated that they are years away from actual deployment of their own systems in the requested frequencies, the FCC should act now to foster immediate consumer vehicle use of VORAD's field-tested and proven safety system

### **III. Conclusion**

The Commission should act expeditiously to allocate a 200 MHz band in the 46 GHz to 50 GHz region for use under Part 15 regulations by vehicular on-board radar systems. Grant of VORAD's request will serve the Commission's

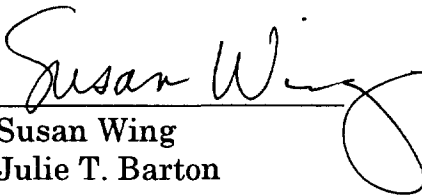
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<sup>14/</sup> Although the AAMA presents its filing as a consensus position of the "American automotive industry," its three members represent only a limited portion of the overall domestic market for vehicle radar safety systems. Thus, it does not represent the several U.S. manufacturers of passenger cars and trucks that are foreign owned, it does not represent manufacturers of imported cars, and it does not represent the majority of U.S. heavy truck, bus and RV manufacturers -- all of whom have an interest in the speedy availability of cost-effective radar-based driver alert systems.

objective of permitting the introduction of new radio technologies expeditiously while increasing the safety of the nation's highways.

Respectfully submitted,

VORAD Safety Systems, Inc.

By   
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(202) 637-5600

February 25, 1994

Its Attorneys

## VERIFICATION

I, Paul J. Bouchard, hereby declare that the following statements are true:

1. I am President of VORAD Safety Systems, Inc. ("VORAD"), and I am authorized to sign this verification on behalf of VORAD.
2. I have read the foregoing Comments.
3. To the best of my knowledge, information and belief founded after reasonable inquiry, these comments are well founded in fact and are warranted by existing law and good faith argument.



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Paul J. Bouchard  
President,  
VORAD Safety Systems, Inc.

Dated: February 25, 1994

## **ATTACHMENT 1**



**Greyhound Lines, Inc.**

P.O. Box 660362  
Dallas, Texas 75266-0362

**February 18, 1994**

**Mr. Paul Bouchard  
President  
VORAD Safety Systems, Inc.  
10802 Willow Court  
San Diego, CA 92127**

**Dear Paul:**

Greyhound Lines recently completed its first full year of service with the VORAD safety system and is approaching 100 million miles of fleet-wide experience with the system, helping to reduce accidents, lower claims costs and provide very useful safety and operating data. As you know, from the very beginning, we have continuously monitored our driver reaction to the VORAD system and we have consistently found that VORAD significantly contributes to driver alertness and safety. In particular, our drivers praise both the system's performance in enhancing safety in darkness, fog and other adverse weather conditions and our ability to work with your company to implement suggestions to modify the system for best results in our busses.

We have recently compiled our 1993 year-end driving safety statistics and are happy to report to you that by year end, Greyhound's total accidents were reduced by more than 20 percent from 1992 levels. This translates to the lowest level in 25 years, which we attribute greatly to the VORAD safety system. With this type of measurable statistical result, we continue to realize a reduction in insurance claims, injuries and other costs associated with vehicular accidents.

As always, we look forward to continuing our fine relationship.

Sincerely,

**James D. Renforth  
Director - Safety Services**

**JDR/dm**



## **ATTACHMENT 2**

**RUBIN, BEDNAREK & ASSOCIATES, INC.**  
CONSULTING TELECOMMUNICATIONS ENGINEERS  
1350 CONNECTICUT AVENUE, NW - SUITE 610  
WASHINGTON, DC 20036

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**ENGINEERING STATEMENT  
IN SUPPORT OF COMMENTS IN RM-8308  
PREPARED ON BEHALF OF  
VORAD SYSTEMS, INC.**

I, Robert A. Bednarek hereby certify: that I am a telecommunications consultant and a principal in the firm of Rubin, Bednarek & Associates, Inc., with offices at 1350 Connecticut Avenue, NW, Washington, DC; that I hold a Bachelor of Science degree in Electrical Engineering from the University of Florida; that I am a certified Engineer-in-Training, with registration as a Professional Engineer pending in the State of Florida; and that I have provided consulting services in the area of telecommunications since 1978. My qualifications in that regard are a matter of record with the Federal Communications Commission.

I, Alan E. Gearing, P.E., hereby certify: that I am a senior engineering associate in the firm of Rubin, Bednarek & Associates, Inc., consulting telecommunications engineers with offices in Washington, DC; that I hold a Bachelor of Science degree in Electrical Engineering from SUNY University at Buffalo; that I am a registered professional engineer in the District of Columbia (since 1979); and that I have provided engineering services in the area of telecommunications since 1973. My qualifications as an expert in radio engineering are a matter of record with the Federal Communications Commission.

The firm of Rubin, Bednarek & Associates, Inc. has been retained by VORAD Safety Systems, Inc., operator of a proprietary vehicular detection and driver alert system. The instant engineering statement is in support of comments in the matter of *Rulemaking to Permit Use of the 76-77 GHz Band for Vehicle Radar Systems* (RM-8308). VORAD supports the general proposal to amend Parts 2 and 15 of the FCC Rules to designate additional millimeter wave bands wherein vehicular radar systems would be permitted to operate. For the reasons which will be outlined in this engineering

statement, VORAD proposes that a frequency band in the range of 46 to 50 GHz be allocated in addition to those bands proposed in the original petition for rulemaking (filed by General Motors Research Corporation - GMRC) and in the comments filed by the American Automobile Manufacturers Association (AAMA).

#### NEED FOR NEW FREQUENCY

The VORAD system originally operated under the provisions of Section 15.245 of the FCC Rules on a frequency of 24.125 GHz. Because of concerns involving the VORAD system emissions causing police radar *detectors* ("fuzzbusters") operating in the 24.125 GHz region to alarm<sup>1</sup>, VORAD sought and received a waiver of Section 15.209 of the Rules to permit operation of its system on a frequency of 24.725 GHz<sup>2</sup>, with a maximum field strength level of 2500 mV/m (measured at three meters from the device). Currently, VORAD has installed systems operating on both frequencies. However, all current new product is for operation on 24.725 GHz.

To date, VORAD has been installed on over 1800 vehicles and operated throughout the country. The VORAD system has been successfully tested on these vehicles and has been demonstrated to significantly enhance safety in many roadway situations (see statement from Greyhound Lines, Inc., included with this filing). While initial deployment of the VORAD system has demonstrated its value in improving highway safety, constraints on minimum required antenna size (5½" by 7½" at 24 GHz) result in the current VORAD system being suitable only for larger vehicles such as trailer-trucks,

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<sup>1</sup> The VORAD system was demonstrated to be completely compatible with the operation of the "radar guns" themselves, as used by various law enforcement agencies.

<sup>2</sup> A 600 MHz frequency change was found to be the minimum shift necessary to resolve concerns with the "fuzzbusters". Tests by VORAD revealed that these type radar detectors typically had extremely wide bandwidths. The average was approximately  $\pm 500$  MHz, with some models able to detect energy over a  $\pm 1000$  MHz range.

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buses, and recreation vehicles. VORAD wishes to develop a system which would be appropriate for use on passenger vehicles. This would require a smaller antenna size and hence a higher operating frequency.

**ADVANTAGES OF 46 GHZ TO 50 GHZ RANGE**

The GMRC rulemaking petition and the comments by AAMA have identified a number of frequency ranges which could accommodate future vehicular radar systems. However, VORAD believes that an allocation in the 46 GHz to 50 GHz range offers advantages not to be initially found in the other proposed bands.

The frequency bands identified in the GMRC petition and the AAMA comments are for systems which are still in development and are still a number of years away from commercial availability. The VORAD system at 24.125 and 24.725 GHz is already in commercial use. Allocating a frequency band which has a harmonic or near harmonic relationship to the existing VORAD system, would allow use of "off the shelf" 24 GHz frequency generating units and frequency doublers to permit rapid development of a cost effective system which, because of the higher frequency, would allow downsizing the antenna to a size acceptable for use on passenger vehicles. No such harmonic or near harmonic relationship exists between the frequencies employed by any existing commercial products and the frequency bands proposed in the GMRC and AAMA filings. Consequently, a system in the 46 GHz to 50 GHz range could be brought to market years before, and much more cost effectively than, systems utilizing the other proposed bands, where the technology has not been fully developed. That is not to say that these other frequencies also should not be made available for vehicular radar systems, only that systems in the 46 GHz to 50 GHz range, and the attendant safety enhancements, can be made available much sooner.

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VORAD has an experimental unit operating at 46.5 GHz, which they would be happy to demonstrate for the Commission or other interested parties. A commercial product based on this unit could be brought to market within approximately six months of a frequency allocation being made. If a different frequency in the 46 GHz to 50 GHz range is made available, commercial products are expected to be available in approximately one year. The additional delay would result from the need to redesign and retool the 46.5 GHz design. At these millimeter wavelengths, frequency sensitive components are extremely narrowbanded and require extensive redesign and testing when the frequency is changed by more than 200 MHz. In either case, 46 GHz to 50 GHz systems can be brought to market much quicker than systems in the other proposed bands.

## **TECHNICAL SPECIFICATIONS FOR THE VORAD SYSTEM**

The current VORAD systems, centered at 24.125 GHz and 24.725 GHz, operate with an antenna input power of 0.5 mW and produce a field strength of less than 2500 mV/m, measured at 3 meters from the device. The nominal bandwidth of the modulated signal (continuous wave, frequency modulation - FMCW<sup>3</sup>) is 2 MHz. However, typical oscillator frequency drift exhibited by devices operating in these frequency ranges results in a frequency tolerance of  $\pm 50$  MHz and the VORAD system occupies an actual bandwidth of 100 MHz. The antenna size for the current VORAD systems is approximately 5½" by 7½", or a surface area of 41.25 square inches.

A VORAD system operating in the 46 GHz to 50 GHz range would require an increase in the maximum permitted field strength to 5000 mV/m (measured at 3 meters from the device). An integral element of Part 15 of the FCC Rules is that the maximum field strength limitations specified increase, in general, with increasing frequency. While such increases are not necessarily linear, VORAD's

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<sup>3</sup> This type of modulation is sometimes referred to as frequency-shift keying (FSK).

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initial work at 46.5 GHz indicates that a doubling of the limitation at 24.725 GHz is reasonable. Input power to the antenna would be approximately 1 mW. The nominal bandwidth of the FMCW (or FSK) modulated signal would remain 2 MHz. However, the frequency drift, which is a linear function of frequency, would be  $\pm 100$  MHz requiring an authorized operating bandwidth of 200 MHz. The required antenna size, expressed in terms of surface area, for a system operating in the 46 GHz to 50 GHz range would be approximately one-fourth that required for the current 24 GHz range systems. This reduced antenna size would result in the VORAD system being more easily mounted and more aesthetically acceptable in a passenger sized vehicle, as opposed to the tractor-trailer and bus sized vehicles on which the current VORAD systems have been installed.

**EXISTING ALLOCATIONS IN THE 46 GHZ TO 50 GHZ RANGE**

Internationally, in Region 2, the 46 GHz to 50 GHz frequency range is allocated to a number of different services, primarily satellite based, and the domestic allocation tracks the international. While the domestic allocation is listed as being for both government and non-government use, except for a small allotment for Amateur and Amateur Satellite use, this frequency range is currently reserved for government use only. The attached Figure 1 depicts the existing allocations in this spectrum region.

It is VORAD's understanding that discussions are ongoing between the National Telecommunication and Information Agency (NTIA) and the FCC to release some of this spectrum for use by non-government entities. Furthermore, it is VORAD's understanding that one of the frequency bands being considered by the NTIA and the FCC lies in the 47.2 GHz to 50.2 GHz range.

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While VORAD would prefer that an allocation be made centered at 46.5 GHz, where it has already developed an experimental system, an allotment with at least a 200 MHz bandwidth anywhere in the 46 GHz to 50 GHz band would be acceptable. The attached Figure 1 shows that, except for a small allocation for radio astronomy at 48.94 GHz to 49.04 GHz, this frequency band is currently allotted to Fixed, Fixed Satellite (earth to space), and Mobile use. Because this frequency range is currently reserved for government systems only, it has not been possible to determine current usage with any degree of accuracy. However, the FCC has coordinated some non-government use and Figure 2 lists the existing users in this frequency range that have been identified. Most of the identified existing users are telephone companies and/or experimental licensees.

**RESTRICTIONS REQUIRED ON AN ALLOTMENT FOR USE BY THE VORAD SYSTEM**

Opening up a portion of the 46 GHz to 50 GHz band to Part 15 users as proposed herein, would not be incompatible with the existing users of this portion of the Spectrum.

Consider compatibility with the existing Fixed Satellite (earth to space) allocation. Assume a satellite in low earth orbit (LEO) 200 miles above the earth's surface. Free space loss would be

$$L_{FS} = 96.58 + 20\text{Log}(f) + 20\text{Log}(d)$$

where  $L_{FS}$  is in decibels,  $d$  is in statute miles, and  $f$  is in gigahertz.

$$L_{FS} = 96.58 + 20\text{Log}(46.5) + 20\text{Log}(200)$$

$$L_{FS} = 175.9\text{dB}$$

Since the VORAD system would operate with a maximum field strength of 5000 mV/m (134 dBu) at 3 meters, the maximum potential interfering field strength from a VORAD system to a LEO

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satellite would be only -41.9 dBu ( $0.008 \mu\text{V/m}$ ), which is equivalent to a received power density of -188 dBW/m<sup>2</sup>. In comparison the typical minimum received power density for the desired satellite signal is -110 dBW/m<sup>2</sup>. In addition, the -188 dBW/m<sup>2</sup> value would be worst case since it assumes that the VORAD antenna is pointed directly at the affected satellite and that the intervening path is unobstructed. Since the antenna for the VORAD system has a narrow beam, would be mounted in the front area of a vehicle, and be directed so as to detect ground based obstacles, it is highly unlikely that an unobstructed direct path to an orbiting satellite would ever occur. Satellites in other than low-earth orbits would be further away and hence be even less susceptible to interference.

Consider next the existing Fixed and Mobile allotments. The VORAD system employs a low operating power; a highly directional, narrow-beamwidth antenna pattern; and the antenna is mounted low to the ground and pointed at ground level obstructions. Consequently, it is unlikely that any interference would be caused to higher powered point-to-point or mobile communication facilities, which would likely have antennas mounted higher above ground and oriented so that the signal path would be well above ground level. As to the potential that the VORAD system would be interfered with by other fixed and mobile users, because of the modulation and encoding scheme employed, the VORAD signal is not very susceptible to other signals and no received interference problems are expected.

VORAD has extensive operating experience with its 24 GHz systems operating under Part 15 criteria (albeit with a waiver for the 24.725 GHz frequency). Operation of the VORAD system has not resulted in any interference caused to or received from other Part 15 devices<sup>4</sup>. Therefore, VORAD

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<sup>4</sup> The phenomena of "fuzzbuster" radar detectors operating in the 24 GHz frequency region being "falsely" triggered by the authorized emissions of the VORAD system cannot be considered interference to these unlicensed devices, since their designed purpose is to detect any radar signals within their frequency band of operation.



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proposes that rules governing the use of a frequency allotment in the 46 GHz to 50 GHz frequency range (for vehicular detection and driver alert systems) mirror the current Part 15 limitations with the following exceptions: 1) The bandwidth allotted must be at least 200 MHz wide; 2) Operation of police radar and similar radar detection devices must be prohibited within  $\pm 1$  GHz from the center frequency of the allotted band; and 3) Permit a maximum field strength of 5000 mV/m, measured at 3 meters from the device. No interference problem would be expected either from or to other users of this new allotment to the extent they fall within the general types of users currently operating under the authority of Part 15. If additional categories of users are permitted in the future, the question of compatibility with the VORAD system would have to be readdressed.

**SUMMARY**

VORAD has an operating vehicular detection and driver alert system operating in the 24 GHz band, which has been proven to improve highway safety. To date, implementation of this system has been restricted to larger vehicles such as tractor-trailers, buses, and recreation vehicles because of the minimum antenna size attainable at 24 GHz. In order to make this technology available on passenger sized vehicles, a smaller antenna size and hence a higher frequency is required.

The FCC and the NTIA are believed to be considering making available for non-government use a portion of the spectrum in the 47.2 GHz to 50.2 GHz frequency range. Because of the ready availability of "off the shelf" equipment which could be employed, making an allotment in the 46 GHz to 50 GHz range, for use by vehicular detection and driver alert systems (such as that proposed by VORAD), would allow this highway safety enhancing technology to be made available to passenger sized vehicles more rapidly and more cost effectively than would be the case for other frequency bands being proposed. In fact, VORAD has an experimental system in operation at 46.5 GHz. Only